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OBSERVATIONS ON THE FISHES OF THE GENUS
NOTROPIS.

BY THEODORE D. A. COCKERELL AND OTIS CALLAWAY.

From our study of the scale-characters of the smaller American minnows, combined with those already known, it appears that *Notropis* must have evolved on the North American continent, from some member of the Pimephalinae. The transition is from *Pimephales* to *Cliola*, and thence to the subgenus *Luxilus* of *Notropis*, especially *N. cornutus*. This indicates an origin for this series independent of the true Leuciscinae, which must have come from the Old World. According to this view *Notropis* typifies a distinct subfamily Notropinae, to include *Notropis* and *Cliola*, with *Hybopsis* and perhaps *Phenacobius* forming an aberrant branch. (*Nocomis kentuckiensis* has a very distinct multi-radiate scale, and must be excluded from *Hybopsis*.)

Cliola smithii Evermann & Cox (the only species of this genus we possess) has the peritoneum red-brown (not spotted), on a silver substratum, just as in *Orthodon* and *Acrocheilus*. The fish is rather deep-bodied, with rather large scales, approaching *Luxilus*. The gill-lamellae are very strongly fimbriate. The scales are broad, with numerous (about 19) apical radii, herein agreeing with the Pimephalinae and with *Luxilus*.

The transition to *Luxilus* is thus sufficiently evident. *N. cornutus* represents the stem-form of *Notropis*, and yet is abundant and wide-spread, showing that it was no failure of this type that led to the production of so many offshoots. The numerous species of *Notropis* seem to be a product of the exuberance of their race, and it may be surmised that some of the minor forms are quite recent, even perhaps post-glacial. In some cases the small size and slender body may doubtless be regarded as an

adaptation to smaller streams, enabling the fishes to populate waters unsuitable to the stem-form.

The accompanying table shows the number of apical radii on the scales of the species of *Notropis* examined by us. It must be noted that the scales are all taken from the same part of the fish, namely, the immediate vicinity of the lateral line, at the level of the beginning of the dorsal fin. There is no doubt whatever that by examining a larger number of scales, especially from large series of the fish, the recorded ranges of variation would in almost every case be sensibly increased. At the same time, we are satisfied that with this caution the table may be regarded as of significance in relation to the evolution of the species. It will be observed that two subgenera, as currently interpreted, are in the table separated into divergent parts. In the case of *Cyprinella* we do not believe that a second group is indicated, but in *Hydrophlox* it appears to be necessary to separate *N. coccogenis* as the type of a new subgenus.

NOTROPIS Rafinesque.

Number of apical radii (counting those only partly developed).

(<i>Luxilus</i>)	<i>N. cornutus</i>	21-27	(<i>Notropis</i>)	<i>N. arge</i>	10-11
(<i>Luxilus</i>)	<i>N. albeolus</i>	19-23	(<i>Chriope</i>)	<i>N. bifrenatus</i>	9-11
(<i>Coccogenia</i>)	<i>N. coccogenis</i>	16-20	(<i>Chriope</i>)	<i>N. cayuga</i>	9-10
(<i>Chriope</i>)	<i>N. heterodon</i>	14-20	(<i>Notropis</i>)	<i>N. sraiini</i>	9-10
(<i>Chriope</i>)	<i>N. muskoka</i>	18-24	(<i>Hudsonius</i>)	<i>N. gilberti</i>	9-10
(<i>Alburnops</i>)	<i>N. bleunius</i>	15-18	(<i>Notropis</i>)	<i>N. jejunus</i>	8-10
(<i>Hudsonius</i>)	<i>N. piptolepis</i>	14-18	(<i>Hudsonius</i>)	<i>N. illecebrosus</i>	8-10
(<i>Cyprinella</i>)	<i>N. galacturus</i>	16	(<i>Notropis</i>)	<i>N. atherinoides</i>	7-10
(<i>Hudsonius</i>)	<i>N. hudsonius</i>	11-14	(<i>Moniana</i>)	<i>N. formosus</i>	6-9
(<i>Chriope</i>)	<i>N. atrocaudalis</i>	12-13	(<i>Cyprinella</i>)	<i>N. nicens</i>	8
(<i>Chriope</i>)	<i>N. anogenus</i>	12-13	(<i>Cyprinella</i>)	<i>N. maculatus</i>	7-8
(<i>Moniana</i>)	<i>N. lutrensis</i>	9-13	(<i>Notropis</i>)	<i>N. stilbius</i>	5-8
(<i>Notropis</i>)	<i>N. scopifer</i>	11-12	(<i>Notropis</i>)	<i>N. leuciodus</i>	6-9
(<i>Alburnops</i>)	<i>N. spectrunculus</i>	10-12	(<i>Notropis</i>)	<i>N. telescopus</i>	5-7
(<i>Alburnops</i>)	<i>N. scylla</i>	9-12	(<i>Hydrophlox</i>)	<i>N. zonatus</i>	6
			(<i>Hydrophlox</i>)	<i>N. chalybeus</i>	5

Chriope 7-24

Alburnops 9-12, 14-17

Hudsonius 9-18

Coccogenia 16-20

Moniana 6-1

Cyprinella 8, 16

Luxilus 19-27

Hydrophlox 5-6

Notropis 5-11

Coccogenia, subgen. nov.

Type, *Notropis coccogenis* (Cope).

"Mouth large, very oblique, . . . lower jaw projecting beyond upper,

The scales of this subgenus are thin, and often very feebly sculptured. *N. muskoka* from Orillo, Ontario, has quite strongly sculptured scales, with the maximum number of radii for this group, sometimes as many as 24, counting the rudimentary ones. It should therefore be regarded as the nearest to the stem-form of *Chriope*.*

The following table is based on the scales:

Scales broader than long.

Scale much broader than long.

Sculpture distinct, radii 18 to 24 *N. muskoka* Meek.

Sculpture weak.

Radii 11 to 13 *N. kendalli* Evermann & Cockerell.

Radii 9 or 10 *N. cayuga* Meek.

Scale somewhat broader than long.

Sculpture distinct; size medium; radii 14 to 20 . . . *N. heterodon* Cope.
Indiana.

Sculpture distinct; size small; radii 9 to 11 . . . *N. bifrenatus* Cope.
(*N. heterodon* has thin scales, the radii irregular and wavy.)

Scales subcircular.

Scale large; sculpture distinct; radii 12 or 13 . . . *N. atrocaudalis* Everm.
Palestine, Texas.

Scale small; sculpture weak.

Radii 12 or 13 *N. anogenus* Forbes.

Radii 7 or 8 *N. maculatus* (Hay).

N. bifrenatus agrees with *heterodon* in having the scales broadly rounded apically.

A provisional scheme of evolution may be suggested—

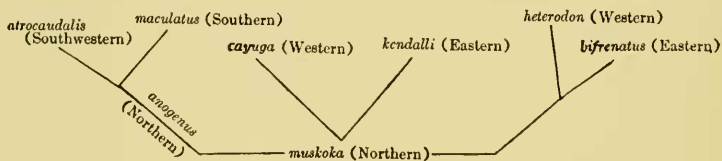


Figure 1.

N. jordani Eigenm. & Eigenm. has not been seen.

Chriope appears to have developed from a *Luxiloid* type independently of the other subgenera; or at least, the other subgenera are not in its ancestry.

ALBURNOPS Girard.

We know little about this group, having only three species. So far as the scales go, the obvious suggestion would be that *N. blennioides* arose from the *muskoka* type. It is a small fish with large, thin, exceedingly broad scales, greatly resembling those of *muskoka*. It has more radii than the other two species examined. *N. spectrunculus* has the scales much smaller, with more distinct sculpture. *N. scylla* is in some ways intermediate.

* According to the teeth, *N. heterodon*, with teeth sometimes 2, 4-4, 2, as in *Lucilus*, should rather be the stem-form.

The following table separates our three species:

Large fish with broad dorsal as well as lateral dark bands; scales subcircular, rather small, sculpture distinct but not strong, radii 9 to 12 *N. scylla* (Cope).
Boulder County, Colorado.

Small fish with reddish back, and no distinct dorsal band; scales broader than long.

With a distinct caudal spot; scales small, radii 10 to 12
N. spectrunculus (Cope).
Swannanoa R., Black Mt., N. C.

No distinct caudal spot; scales large, very broad, radii 15 to 18
N. blennioides (Girard).
Guadalupe R., Texas.

HUDSONIUS Girard.

The scales of the four species we possess can be separated thus:

Scales very broad.
Size medium *N. piptolepis* (Cope).
Boulder County, Colorado.

Size very small *N. gilberti* Jordan & Meek.
Scale moderately broad.

Larger, broader *N. hudsonius* (DeWitt Clinton).
Chautauqua Lake, N. Y.

Smaller, rounder *N. illecebrosus* (Girard).
Spring Brook, Neosho, Mo.

The junior author has tabulated them as follows:

Sculpture of scales distinct.
Radii 11 to 14; scale large *N. hudsonius*.

Sculpture weak.
Scale of medium size.

Nuclear area broad; radii 14 to 18 *N. piptolepis*.

Nuclear area round; radii 8 to 10 *N. illecebrosus*.

Scale very small; radii 9 or 10 *N. gilberti*.

The fishes themselves may be tabulated thus:

Head short; large species (Great Lakes southeastward) . . *N. hudsonius*.

Head comparatively large; small, slender species.

Eye very large (Lower Arkansas R. basin) *N. illecebrosus*.

Eye moderate *N. gilberti* and *N. piptolepis*.

We do not seem to find a stem-form here; the arrangement would seem to be—

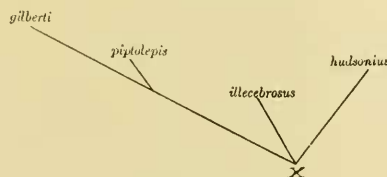


Figure 2.

On account of the teeth, *Hudsonius* can not be derived from *Chriope* or *Alburnops*. It appears to be a separate branch from the Luxiline stem.

MOXIANA Girard.

Scale extremely broad, quite large; radii 6 to 13

N. lutrensis (Baird & Girard).

Boulder County, Colorado.

Scale not nearly so broad; radii 6 to 9, very far apart

N. formosus (Girard).

Colonia Juarez, Mexico.

N. formosus is a small, deep-bodied fish, the pigment so arranged as to produce a conspicuous cross-hatching. There is a dark, narrow dorsal band. Except for size, it reminds one rather of *N. cornutus*.

This group seems to be a separate branch from the Luxilines, but considerably modified.

CYPRINELLA Girard.

Of this large group we have only two, *N. niveus* (Cope) from Raleigh, N. C., and *N. galacturus* (Cope) from North Fork of Holston River, Saltville, Va. They are much alike; warm reddish dorsally, the sides silvery. *N. galacturus* has the eye much larger than that of *niveus*. They look just like *N. albeolus*, except that they are not so deep-bodied. (The eye of *niveus* is very much smaller than that of *albeolus*; diameter $3\frac{1}{2}$ mm. in *niveus*, 5 in *albeolus*.)

The scales are moderately broad; they may be separated thus:

Radii numerous (about 16), but feeble and evanescent, close together; some specimens have rudimentary basal radii *N. galacturus*.

Radii few (about 8), more or less wavy, very far apart; sculpture distinct *N. niveus*.

Cyprinella may be derived from the Luxilines through such forms as *N. albeolus*. This applies to the species examined; we do not know whether or not the others would conform.

LUXILUS Rafinesque.

Scales large, with very distinct sculpture; radii numerous. Fishes deep-bodied, *N. cornutus* (Mitchill) large and with much dark color in dorsal region; *N. albeolus* (Jordan) smaller, and all subdorsal area pale reddish. Both have the scales very broad. *N. albeolus* reminds one of *N. atherinoides* and *jejunus* in *Notropus* s. str., but it is deeper bodied, and distinguished by the broad scales.

Nuclear area very broad, $\frac{1}{4}$ from base; radii 21 to 27; scale partly covered with rather thick skin *N. cornutus*.

Nuclear area circular, $\frac{1}{5}$ from base; radii 19 to 23 *N. albeolus*.

Raleigh, N. C.

We have *N. cornutus* from Cross Lake Thoroughfare, Maine, and Boulder County, Colorado, an enormous range!

HYDROPHILOX Jordan.

From this we have separated *N. coccogenis* as a subgenus *Coccogenia*, but for convenience of comparison we throw it into the following table:

Small fish, about 2 inches long, with broad, dark, very conspicuous lateral band; scales subcircular or even longer than broad, sculpture distinct, radii 5 to 8, circuli irregular *N. chalybeus* (Cope).

Buckhead Creek, Millen, Ga.

Larger fish (over 3 inches), with silvery sides and no dark band.

Scales extremely broad, with radii 16 to 20 . . . *N. coccogenis* (Cope).

Tellico R., Tenn.

Scales circular or nearly so, the base flattened, radii about 6, circuli regular *N. zonatus* (Agassiz).

White River, Arkansas.

N. universitatis Evermann & Cockerell (*N. zonatus* var., Univ. of Colorado Studies, V. 1908, p. 170).

N. zonatus and *chalybeus* are very distinct, and may not be properly associated in the same group.

NOTROPIS s. str.

Although we have a number of species of this group, the range of variation in the radii of the combined series is remarkably small. Instead of being the stem-form of the genus, as its name might suggest, this appears to be the last of the end-forms.

N. jejunus, *leuciodus*, *stilbius*, *telescopus*, *atherinoides* and *swaini* are all small fishes (but our *atherinoides* must be young) with large eye and broad lateral silvery band, very much alike. *N. arge* looks different; much larger (ours $4\frac{3}{8}$ inches), with dark lateral band. *N. scopifer* is intermediate in size, with sides silvery; a deeper-bodied fish than *arge*, with convex back (back of *arge* is almost straight). *N. arge* has scales feebly sculptured, with few radii; *scopifer* has them strongly sculptured, the radii variable but often more numerous. *N. arge* has the distance from nostril to eye greater than breadth of nostril; *scopifer* has it less. The snout is shorter in *scopifer*.

The six species which are so much alike, separate upon external examination as follows:

Northern, deeper-bodied species, the sculpture of the scales distinct.

Eye larger, diameter 4 mm. *N. atherinoides* Rafinesque.
Medicine Hat, Canada.

Eye smaller, diameter 3 mm. *N. jejunus* (Forbes).
Red River of the North, Moorehead, Minn.

Southern species, slender-bodied; hind part of head above black or plumbeous. A conspicuous black spot at base of caudal fin; sculpture of scales weak.

Scales of lateral line with little dark spots . . . *N. telescopus* (Cope).
Indian Creek, Cumberland Gap, Tenn.

Scales of lateral line without such spots *N. leuciodus* (Cope).
Tennessee.

No such spot at base of caudal fin; sculpture of scales distinct.

Snout shortest of the four southern species *N. swaini* Jordan.

Comal Springs, New Braunfels, Texas.

Snout the most pointed of the four southern species; scales very silvery *N. stilbius* Jordan.

Clinch River, Tenn.

The species separate on scale characters thus:

Scale longer than broad 1.

Scale about as broad as long; radii far apart and irregular . *N. stilbius*.

Scale broader than long 2.

1. Sculpture very strong; radii all complete, far apart, 8 to 10 . *N. jejunus*.

Sculpture not strong; radii not all complete, 6 to 9 . . . *N. leuciodus*.

2. Sculpture strong.

Scale very large, circuli irregular, nucleus $\frac{1}{8}$ from center, radii 10 or 11 *N. arge*.

Scale large, radii 11 or 12, wide apart; lateral circuli remarkably wide apart *N. scopifer* Eignm. & Eignm.

North Dakota.

Scale medium, radii 7 to 10; circuli regular; nucleus $\frac{1}{4}$ from base

N. atherinoides.

Sculpture distinct but not strong, radii 9 or 10; nucleus $\frac{1}{3}$ from base; scale covered with skin *N. swaini*.

Sculpture weak; radii 5 to 7, far apart; circuli regular; nucleus $\frac{1}{4}$ from base *N. telescopus*.

We have considered whether this large genus might be subdivided. It would be possible to separate *Luxilus*; but inasmuch as most of the other subgenera appear to radiate from this type, it would apparently be necessary to regard nearly all of them as independent genera, if any. Perhaps at some later date, with more experience and better materials, a division of the genus may be undertaken, but it does not seem practicable at present.

For nearly all the specimens used in this paper we are indebted to the U. S. Bureau of Fisheries.